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By- Stott, Leland H.; Ball, Rachel S.
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A study was conducted to identify types of mental operations of 4- and 5-year-olds and to relate them to the child's age and the educational level of the mother. The sample consisted of 423 white English-speaking children of American parentage, evenly divided by sex and as evenly distributed as possible over the 12-month-age range of 4 to 5 years. Their mothers' education consisted of elementary, secondary, or college level achievement. Items from the Merrill-Palmer Scale and the Guilford model were selected and tested for ability to identify thinking activities. A factor analysis identified six specific types of thinking: two convergent, two divergent, one cognitive, and one maturational. For 4- to 5-year-olds, sex differences were relatively insignificant. Age differences were significantly related to the convergent, cognitive, and maturational abilities, but not to the divergent type. The mothers' education was related to four of the six abilities, and the area of residence was related to three of the six abilities. A "Q" analysis indicated that children could be classified by "types." Thus, environmental factors are important in cognitive development. Appendixes contain tabulated data and directions for administering the tests. (JS)

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Leland H. Stott and Rachel S. Ball
The Merrill-Palmer Institute
June 1968

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We likewise acknowledge our indebtedness to the Psychology Department of Arizona State University for providing office space, facilities, and vital assistance in carrying out the "Western" half of the project.

We are deeply appreciative of the help we received from our consultant Dr. Philip Merrifield, who not only provided vital technical advice from the beginning, but also supervised the computer programming and the analysis of the data. Dr. Irving Sigel, Chairman of Research at Merrill-Palmer, gave us very helpful consultation, and much help in setting up our tentative test battery, for which we are grateful.

We are extremely grateful to those persons who so faithfully and efficiently coordinated the work and actually did the testing at both the Western, and the Eastern centers. And to the more than 400 children, their mothers and in many instances, the directors and teachers of the nursery schools where they were found, we also owe a debt of gratitude.

SUMMARY

This research is concerned with the thinking abilities of 4 to 5 year-old children. Guilford's (1967) model of the human intellect was adopted as a theoretical framework for the study.

The project was designed to seek answers to the following questions:

1) Is it possible to identify and appraise differentially in 4 to 5-year old children two general types of mental operation, viz., convergently productive thinking and divergently productive thinking?

2) To what extent are certain aspects of the 4-year old's environment related to his facility to perform these operations? Is the educational level of parents, particularly the mother, a conditioning factor in the development of these abilities?

This particular investigation involved only white, English speaking, 4 to 5-year old children of American parentage. The first requisite was to put together an instrument for evaluating the thinking activities of young children. In order to develop such a test instrument, considerable study was made of the earlier tests designed for 4-year-old children as to their meaning in terms of specific mental abilities as hypothesized in the Guilford model. Several of the test items of the present Merrill-Palmer Scale that had been shown to have "factor invariance" in, and to be valid tests of the specific thinking abilities in which we were interested were immediately accepted for the tentative scale. Most of these were of the convergent type of thinking ability. A tentative testing program was used to identify test items that required divergent and convergent productive abilities. It was our objective also to include some items that were "cognitive" in nature.

Our immediate goal was to obtain test protocols from 400 children as evenly distributed as possible over the 12 month age range, and equally divided as to sex. Since there were two centers of operation, half of the tests were obtained from the Metropolitan Detroit Area, the other half from the Phoenix-Tempe, Arizona area, and from two communities in California.

The subjects were selected in such a manner as to insure a fair representation of three general levels of education of mothers. One fourth were to be from mothers with only an elementary school education, one half from mothers who were high school graduates, and one fourth from mothers who were college graduates. It proved to be difficult to locate and to test the full quota of children whose mothers had only elementary school education.

The final count of test protocols was 426. Three of these were found to be not sufficiently complete for certain of the statistical analysis. Most of the findings therefore, are based upon 423 cases.

The examiners who did the testing were all capable individuals with adequate training in psychology, with keen interest in the project,

and with ability to work with children.

Scoring procedures were carefully worked out and the scoring of the protocols was done by the two investigators. The scores were tabulated for computer card punching.

The programming and computer work was done under the direction of our consultant, Philip Merrifield. This work involved correlation and factor analyses. After careful consideration of preliminary results, the 22 item-scores were retained for the final analysis.

Principal components were extracted. Although these axes were machine rotated to the Varimax criterion, graphic rotations led to a more meaningful simple structure, and were used in factor interpretations. Factor scores were then computed.

One of the objectives was to determine whether there was evidence of "types" of children in the data. For this purpose "Q" type factor analyses were made in which the individual children became the "variables" and the 22 test-item scores were the "population". Thirty-one children were selected for the analysis in such a way as to provide for different score patterns among them.

Finally a correlational analysis was made of the children's thinking abilities (factor scores), and the environmental and other classificatory variables.

Findings: In the analysis of our data, 6 specific sorts of "thinking" ability were identified. Two of these were of the convergently productive sort - "ability to organize spatial systems" and "speediness in spatial modeling". Two were of the divergent variety - "Ideational fluency" and "originality". One factor, cognitive in nature was identified as a "general reasoning" ability. The remaining factor is clearly one of "fine muscular control" largely maturational in nature.

The correlational analysis revealed (1) that at this age level(4-5 years) sex differences are relatively insignificant. There was a slight trend for girls to be superior in the "general reasoning" ability. An interesting side light was the boys significantly more frequently than girls, gave "aggressive" replies to the question, "What can you do with a knife". (Action Agent, 4).

(2) Within the 12 month age range there were low, but statistically reliable correlations with age of the two convergently productive abilities, the cognitive ability and the psychomotor factor. Correlations of the divergent abilities with age were insignificant and very nearly zero.

(3) The level of mothers' education was found to relate significantly to 4 of the 6 ability variables. "General reasoning" was most

related. "Ideational fluency", "speediness in spatial modeling" and "originality" also yielded correlations significantly greater than zero. All of these abilities seem to relate to child behavior in which mother could easily become involved at an intellectual level.

(4) Area of residence as a variable was found to be significantly correlated with three of the ability variables: "ability to organized spatial systems", "ideational fluency", and "originality". We can only suggest two possible bases for these differences. The western sample in greater proportions came from university neighborhoods, and more "privileged" communities; the midwestern sample was from more cosmopolitan, big city areas. The other possibility is that the regional difference could have been due in part to differences in testers.

(5) The "Q" analyses gave some substantial evidence that children in their ability patterns could be classified by "types".

Contents

The Identification and Assessment of Thinking Ability in Young Children

Introduction

Purposes and Objectives of the Overall Research Program

The investigation herein reported is the second in a series concerned with mental functioning and its development in early childhood. Our overall program involves four main objectives. First, it seemed important to obtain a realistic view, and to make an evaluation of the current mental testing situation with reference to young children.

Another major purpose was to investigate the "structural" nature of preschool mentality. Much was already known concerning the structural components of the young adult intellect (Guilford, 1967). A number of factor-analytic studies have also been made at various school-age levels (McCartin and Meyers, 1966; Merrifield, Guilford and Gershon, 1963). However, there is a paucity of empirical evidence regarding the extent to which differentiation of specific mental functions and abilities has already taken place at age levels below five years. Our specific interest in our earlier study (Stott and Ball, 1965) was to determine which particular mental operations are involved in the children's responses to the widely used tests of intelligence. To what extent would different scales elicit the same pattern of abilities (show the same or different ability-factor content) at particular preschool-age levels? To what extent would each particular test involve the same pattern of abilities in children at different age levels? These two major objectives were main concerns of the first project in our series (Stott and Ball, 1965).

Analysis of the Present Project

In the earlier study, however, the data consisted of children's responses to the items of the commonly used tests, which had been constructed in terms of earlier conceptions of the structure of mentality and its development. In recent years, with the development of newer, more efficient techniques and facilities for statistical analysis, much has been learned about the structural nature of the human intellect. In the well known Guilford model (Guilford, 1967), for example, three equally important aspects of each specific ability are postulated: process or operation, content or medium of the object of thought, and the nature or form of the object or product of thinking. Each ability is describable as the confluence of one kind of process, one kind of content and one kind of product (Guilford, Green, Christensen, Hertzka and Kettner, 1954; Hoepfner, Guilford and Merrifield, 1964; Merrifield, in Klausmeier and Harris, 1966). We chose to emphasize differentiation of kinds of process, and particularly to contrast cognition, convergent productive thinking, and divergent productive thinking. Secondarily, we focused on the distinction between semantic (meaning of words) and figural (spatial configuration) kinds of content.

In order more adequately to determine whether and to what degree these various abilities have become differentiated in children at the different preschool age levels, it was obviously necessary to obtain data derived from test items specifically designed to reveal the presence and the functional level of these abilities. To make a contribution in this area was a primary purpose of the present project.

We were also much concerned with the questions of the extent to which cultural and home-environmental factors influence the differential development of mental functioning during these early years of childhood. In recent years, this has become an important focus of interest among child development researchers. More and more emphasis generally is being given to the importance of adequate and appropriate stimulation in early cognitive development. The assumption is that the amount and quality of mother-child interaction is a crucial factor (Deutsch, 1964; Bernstein, 1960; Hess, 1964; Hess and Shipman, 1965). To obtain some evidence on this important question was a further purpose of our research program.

Our final objective is to develop and standardize tests for the measurement of the various specific mental functions and abilities which characterize the different preschool age levels (ages two to six years). Only that portion of the overall study dealing with four-year-olds is here reported.

Briefly in summary, our specific purposes in this study were (1) to investigate more thoroughly the three sorts of mental operation, or modes of thinking in young children, which have been labeled "divergent production", "convergent production" and cognitive thinking as they are manifest in 4 to 5 year-old children, and (2) to investigate the relationship between children's abilities and their mothers' level of education.

Divergently Productive Thinking

Situations commonly arise throughout life which call for a type of thinking which produces a variety of appropriate reactions, or alternative courses of action. Volume of appropriate and meaningful output is often demanded. This particular category of thinking has been well identified and described as an aspect of human ability. Various divergently productive abilities have been described in a number of investigations of "creativity." In this connection Guilford (1967) wrote:

> "Certain hypotheses about abilities that should be of special relevance for creative thinking (Guilford, 1950) led to the search for abilities having to do with fluency of thinking and flexibility of thinking, abilities concerned with the ready flow of ideas and with readiness to change direction or to modify information. The first large factor analysis that was aimed at the investigation of these hypotheses (Wilson, et. al., 1954), and others that have followed, have found not one kind of fluency factor but three, not one kind of flexibility factor but two, besides a factor that was called by the term originality."

As Guilford (1967) points out, the three fluency factors identified in recent research are the same as those found by earlier investigators. These were called "word fluency" (Thurstone, 1939). "Ideational fluency" (C. W. Taylor, 1947), and "associational fluency" (Fruchter, 1948).

The related ability to elaborate upon ideas, to fill in with details and illustrative instances has also been hypothesized (Berger et. al., 1957). Thus the category of divergent production abilities includes the abilities previously called fluency, flexibility, originality and elaboration.

At least two of the specific abilities belonging to this category have been verified in six-year-old children (Orpet and Meyers, 1965; McCartin and Meyers, 1967), and at certain preschool levels (Stott and Ball, 1965). This divergent type of thinking is frequently observable in children during social and dramatic play. The tests included have been designed to standardize a sample of this type of activity.

Richness of imaginative production and wealth of ideas (flexibility and ideational fluency) vary widely even among preschool children, and of course a relatively high level of this divergent production ability marks the "leader" among children (Stott, 1962).

Convergent Productive Thinking

The other type of thinking activity with which we are here concerned is convergently productive in its orientation. Throughout life one must cope with situations which in each case requires a particular correct solution. Early in the child's life he is asked to perform specific functions and to follow specific directions. His efforts and his thinking in each case must "converge" - be directed toward a single desired end, or a particular correct answer. Again, individual differences are evident at any age level in this ability category.

It is interesting to note that even though problem solving activity of the convergent productive sort is a very common kind of mental functioning, it is one of the least explored aspects of the intelligence of young children. (Guilford, 1967 p. 171). In the few available studies, convergent production factors have been suggested at age 14 (EL-Abd, 1963), at age 6 (McCartin and Meyers, 1966) and in certain tests at preschool ages (Stott and Ball, 1965).

As was stated above, little is known concerning the changing structure of mentality in early childhood in terms of hypothesized specific abilities. Few attempts have been made heretofore to provide testing procedures or measuring scales for the investigation of abilities of preschool children from the point of view of the "structure of intellect."

General Procedures

The Research Instrument

Our first task was to assemble a set of test items designed to stimulate divergent and convergent production in 4 to 5 year-old children,

and in terms of which levels of abilities in individual children could be appraised. Eight items from the Merrill-Palmer Scale were immediately selected since their invariant factor status with respect to thinking production had been established in previous studies (Stott and Ball, 1965; McCartin and Meyers, 1966). Tests that had been developed for older children (Guilford, Merrifield and Cox, 1961; Guilford and Hoepfner, 1966) to differentiate divergent and convergent functioning were examined. Certain of these were reduced in difficulty and otherwise adapted for use with four-year-olds. Others of them furnished ideas for devising new items. A tentative set was thus assembled for a preliminary tryout on 4-year-old children.

The criteria for the retention of an item was its suitability in terms of difficulty level, its interest value for young children, and the ease with which it could be administered and scored. As a result of the preliminary study those items that were found to lack interest value, or were too time consuming were eliminated. Certain items were shortened or otherwise modified in ways to retain or enhance their interest value. Some tests were included which clearly involved cognitive thinking, perhaps even more than either of the productive thinking operations. It was aimed to arrive at a total test composite that was not too long or fatiguing for the child. The list of test items finally chosen for the study of 4 to 5 year-old functioning is shown in Table 1. The hypothesized factor identifications for the different probable aspects of the item's meaning in each case are also suggested.

Items involving divergent production were found to be much more difficult to come by, and considerable time and effort were required during the preliminary experimental period to provide a sufficient number of such items for inclusion in the test instrument. It will be noted in the listing (Table 1) that the child's response to certain of the items could be evaluated and scored in two or more ways. The 18 items thus provided 22 possible tests including nine involving convergent production, eight involving divergent production, five involving cognition and two items which we tentatively regarded as "maturational" in nature (Items 4 and 5). It was expexted, of course, that tasks including more than one kind of ability would be factorially complex.

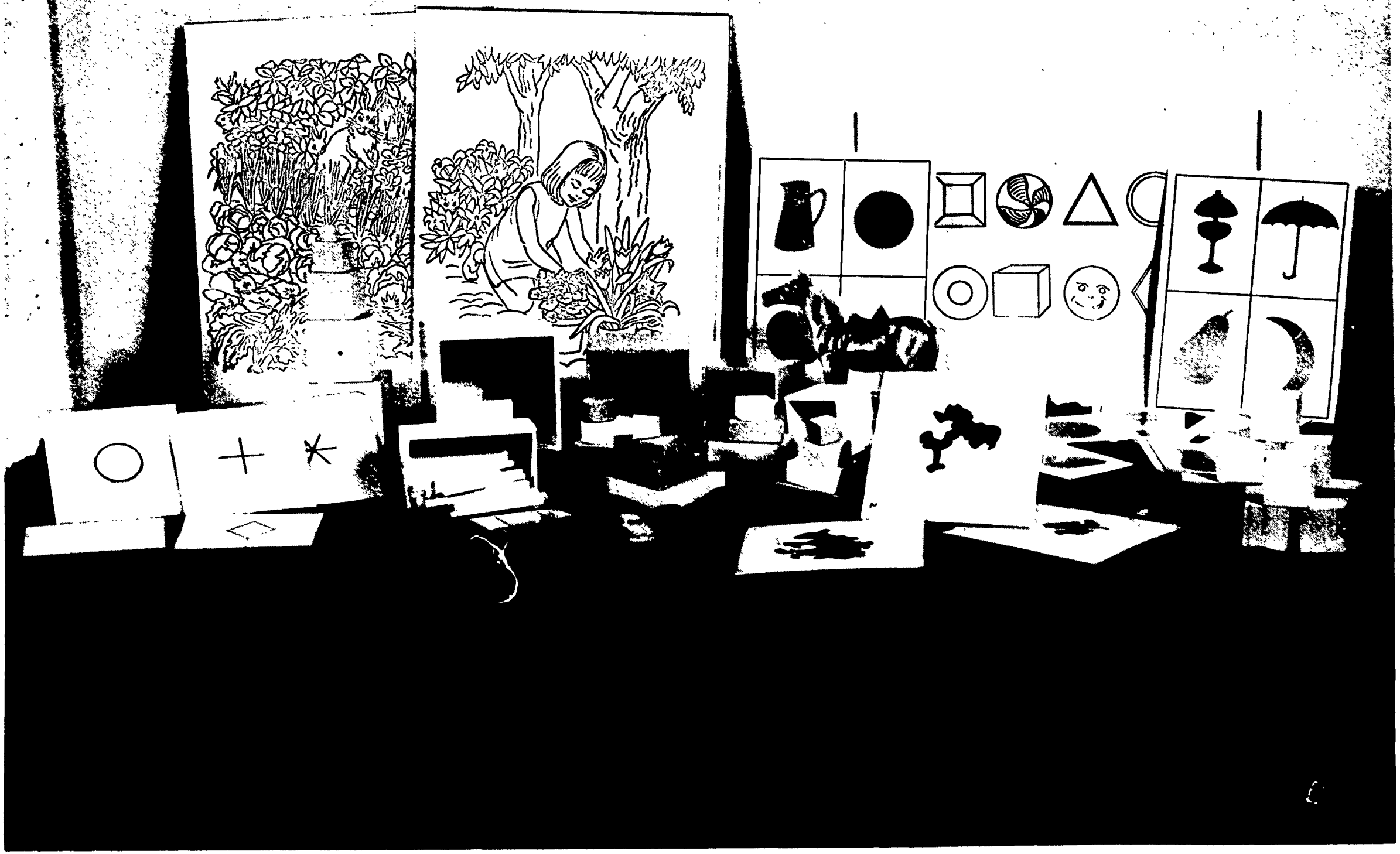
For administration, the tests were assembled in a sequence which was judged to be favorable for maintaining the child's interest. A test record booklet was provided with adequate space for recording the child's verbal responses and comments as well as descriptions of the child's behavior during the test. The first page of the booklet was a face sheet for recording general information about the child, his family and general living situation, the educational level attained by his mother, occupation of the father, and the amount of time generally spent by each parent with the child.

A manual of instructions for the administration of the tests was developed from preliminary try-outs (See Appendix I).

TABLE 1

Final Test Items Selected After The Trial Period With 4 to 5 Year-Old Children, with Hypothesized Factor Content for Each Item

Test Item	Hypothesized Factor Content
1. Little pink Tower	cognition convergent production
2. 3-cube pyramid	cognition convergent production
3. 6-cube pyramid	convergent production
4. Hidden figures (3 cards)	cognition and convergent production
5. Fist and thumb	maturational level indicator
6. Thumb and fingers	maturational level indicator
7. Round things	divergent production
8. Ambiguous forms (3 cards) Ideas	divergent production
9. Ambiguous forms (elaboration)	divergent production
10. Action agent - no. of replies	divergent production
11. Agent action - no. of replies	divergent production
12. Agent action - no. of elaborations	divergent production
13. Copy star	convergent production
14. Copy diamond	convergent production
15. Stick test - production	divergent production
16. Food naming	divergent production
17. Block sorting - relations	cognition
18. Block sorting - flexibility	divergent production
19. Word meaning	cognition divergent production
20. Figure completion	convergent production
21. Directions test, complexity, color and position	convergent production
22. Stick test, matching	convergent production



Display of Test Materials Used in the Study of Thinking Ability

Selection and Training of Project Personnel

A search was made for qualified individuals who were available to assist with the data collection. They were selected according to such criteria as educational background, psychological sophistication, and interest in the project. It was important also that they have appreciation for the importance of following strict procedural directions and maintaining experimental controls. At the same time experience with young children and liking for them, with ability to gain rapport with them were considered especially important for work with preschool children.

One well qualified person was selected who did the testing in the Detroit area under the supervision of Stott. In Arizona several individuals participated in the testing under the supervision of Ball. All were advanced students of psychology - in one instance a member of the university faculty. In each center part of the testing was done by the investigator. We were fortunate in obtaining at each center a well qualified and interested person to serve as facilitator and coordinator, who located sources of child subjects, and made arrangements with mothers and nursery schools for the testing.

Selection of Subjects

In order to limit the problem somewhat in terms of number of variables it was decided to control the factor of race by using only English speaking, white children in this particular study. No attempt was planned to control for, or study the effects of social class per se, but since the preschool child generally is in closest association with his mother his cognitive development is undoubtedly largely shaped by the quality of stimulation his mother provides. On the theory that quality of stimulation a preschool child receives depends to some degree upon the level of his mother's education, it was decided to include mother's educational level as a selection criterion. Hence three levels were arbitrarily chosen: elementary school, high school graduation, and college graduation. Since the high school graduate level is most commonly attained by women prior to marriage in our culture, our plan called for 50 percent of our young subjects to have mothers with four years of high school, but with not more than one year of additional education or training. It was hoped that we could obtain about equal numbers of cases with college graduate mothers and with mothers of ninth grade or less education to constitute the other 50 percent.

Our plan called for a total of 400 child subjects. Since there were two bases of operation in this project, the number of subjects tested at the two centers were planned to be approximately equal and with the same distributions with respect to education of mother. An effort was made also to obtain equal numbers in each group whose ages fell within the age ranges 4-0 to 4-6 and 4-7 to 4-11, and equally divided as to sex. Table 2 shows the actual distribution of the subjects tested in terms of these various selection factors.

TABLE 2

Distribution in Terms of Geographic Location, Mothers' Educational Level, and Sex of Children Tested

	Mothers' Education Level	Boys	Girls	Totals
Midwestern Sample	Elementary	27	23	50
	High School	51	50	101
	College	33	35	68
	Total	111	108	219
Western Sample	Elementary	23	29	52
	High School	51	53	104
	College	26	25	51
	Total	100	107	207
Total Sample	Elementary	50	52	102
	High School	102	103	205
	College	59	60	119
	Total	211	215	426

Procedures for Scoring the Test Items

Certain of the test items were timed and offered no difficulty in scoring. However, many of the items required careful study to determine an appropriate method of scoring. This was done independently by the two investigators and the determination of the final scoring was arrived at through conference with the purpose of making it as non-complicated and objective as possible. The 426 protocols were scored independently and checked by the two investigators. The data as collected and scored were transcribed from the original tabulation sheets to a form more conventent for the preparation of punched cards.

In the early tabulation process, it was discovered that several of the time-to-completion distributions of scores were skewed, and they were therefore C-scaled for analysis. Other scores were entered in their natural form.

In order to ascertain that the requirements of the Pearson-r were met, and to provide scores in a form appropriate to the Q-methodology to be applied later, a scheme was devised to transform each measure into the closest possible approximation of a Gaussian 5-category scale. Following the area-transform procedures typically used in developing C scale or stanine scores, five categories were defined having as their limits the following cumulative proportions:

Value	Limits (cp)	Limits (cf)
1	.0000- .0667	1-28
2	.0668- .3084	29-130
3	.3085- .6914	131-292
4	.6915- .9331	293-294
5	.9332-1.0000	395-423

Analysis and Findings

The Factor Analysis

The intercorrelations among the scaled values for the 22 test item scores (N = 423[1]) appear in Table 3. All are Pearson-r's except for those involving variable 5, 6, 13, 14, 17 and 18, which are point-biserial r's, because those variables are dichotomous. Correlations among dichotomous items are phi coefficients. Because the dichotomies arose from the evaluations of the tasks and were not arbitrarily derived from clearly continuous variables, no adjustment for continuity was made.

Principal components were extracted using the Honeywell 2200 installation at the Computer Center, Kent State University (as were all other major computations). The initial estimates of communalities were the highest correlation of a variable with any other. The program used

[1]Because of incomplete data, three cases were eliminated reducing the number to 423.

TABLE 3

Test Item Intercorrelation Matrix

	Little Pink Tower 1	3-Cube Pyramid 2	6-Cube Pyramid 3	Hidden Figures 4	Fist & Thumb 5	Thumb & Fingers 6	Round Things 7	Ambiguous Forms; Ideas 8	Ambiguous Forms; Elaborations 9	Action Agent Replies 10
1										
2	.272									
3	.154	.225								
4	.134	.161	.307							
5	.032	.057	-.013	.048						
6	.072	.104	.165	.215	.283					
7	.191	.142	.251	.330	.020	.133				
8	.070	.099	.129	.229	-.073	.031	.223			
9	.022	.182	.175	.312	-.092	.011	.245	.407		
10	.125	.269	.207	.313	.037	.192	.366	.275	.268	
11	.004	.061	.142	.182	-.029	.112	.246	.268	.231	.341
12	.061	.215	.290	.299	-.002	.123	.336	.313	.424	.435
13	.064	.136	.213	.235	.005	.040	.227	.054	.228	.189
14	.088	.085	.141	.152	.067	.078	.072	.050	.101	.049
15	.045	.136	.084	.098	.062	.119	.137	.136	.203	.223
16	.197	.178	.130	.308	.012	.078	.293	.232	.243	.365
17	.168	.071	.164	.271	.081	.130	.172	.091	.049	.205
18	.118	.048	.202	.187	.041	.085	.134	.062	.072	.106
19	.087	.072	.174	.248	.068	.138	.277	.330	.275	.366
20	.112	.153	.312	.268	.004	.098	.192	.061	.142	.211
21	.214	.186	.284	.364	.025	.162	.395	.204	.255	.360
22	.192	.147	.258	.300	.077	.226	.151	.030	.065	.194

TABLE 3 - cont'd.

Test Item Intercorrelation Matrix

	Agent Action Replies 11	Agent Action Elaborations 12	Copy Star 13	Copy Diamond 14	Stick Test Production 15	Food Naming 16	Block Sorting Relations 17	Block Sorting Flexibility 18	Word Meaning 19	Figure Completion 20	Directions Complexity 21	Stick Test Matching 22
11												
12	.463	.										
13	.051	.209										
14	.014	.096	.239									
15	.148	.273	.070	.118								
16	.308	.383	.195	.027	.154							
17	.115	.086	.116	.127	.026	.162						
18	.092	.098	.081	.019	.140	.104	.203					
19	.345	.333	.095	-.018	.058	.275	.200	.106				
20	.088	.169	.271	.169	.175	.153	.122	.212	.076			
21	.254	.349	.234	.135	.156	.293	.274	.192	.363	.218		
22	.071	.165	.284	.149	.044	.136	.136	.148	.127	.343	.208	

iterates until stable communalities are obtained for a specified number of factors, in this case five. A sixth factor was computed and presented in the computer output.

The six principal componentsobtained are presented in Table 4. It will be noted that the lower eigenvalue (root) for these six components is only .2681, quite a bit below the values frequently recommended. However, in this study some logically distinct factors were represented by only two or three measures; thus, the choice to accept components with relatively small eigenvalues seems justified. If one wishes to restrict interpretation to the first two components whose eigenvalues exceed unity, an inspection of the first two columns, A and B, suggests that the major differentiation would be between the verbal fluency group (variables 8, 9, 10, 11, 12, 19) and the general reasoning group (3, 4, 13, 20, 21, 22).

The first five components were rotated to the varimax criterion with the results presented in Table 5. Because it appeared that the sixth component would contribute to further differentiation of the factor space, and because the varimax solution seemed unsatisfying, the six components were rotated graphically to joint criteria of hyperplanar scope and orthogonality of factors. The results, which appear to meet the intuitive notions of simple structure and to exhibit factors that are interpretable rather easily, are shown in Table 6.

Factor Interpretation

The six factors with their significant factor loadings follow below. Loadings of .30 or more absolute value are included plus, in parentheses at the end of the list those loadings for items which nearly approximate this minimum and which seem logically to bear relationship to the factor.

Factor A - Convergent Production of Figural Systems (NFS)

.52	13	Copy Star
.48	20	Figure completion
.40	22	Stick test, matching
.35	3	Six-cube pyramid
.34	4	Hidden figures (C.37)*
.33	14	Copy diamond

Hyperplane: 1, 5, 6, 8, 11, 17, 19

This group of measures was quite easily identified. All involve production of a clearly defined percept. Most percepts are sufficiently complex to warrant the category of systems, at least considering the age of the examinees. Perhaps a more popularly meaningful name for this factor is Ability to organize spacial systems, a variety of convergently productive thinking.

It is noteworthy that the psychomotor tasks (5, 6) and the verbal tasks (8, 11, 19) are in the hyperplane of this strong factor.

*A letter and number in parenthesis refers to another factor and the loading that item also bears of that factor.

TABLE 4

Unrotated Factor Matrix (Principal Components)

Variable	Roots	Communality	I	II	III	IV	V	VI
1	4.2349	.3545	.272	-.255	.068	-.453	-.116	.003
2	1.1552	.3410	.342	-.130	-.072	-.389	-.236	-.013
3	.6674	.2571	.452	-.208	-.095	.009	.009	.045
4	.4871	.3775	.573	-.170	-.015	.110	-.087	-.136
5	.4268	.2400	.052	-.231	.340	.072	.233	-.110
6	.2681	.3578	.275	-.256	.373	.131	.267	-.058
7	.2009	.3086	.547	-.001	.013	-.031	-.089	.023
8	.1951	.2964	.432	.326	-.023	-.026	-.041	-.201
9	.1148	.3981	.501	.275	-.255	.033	.068	-.239
10	.0994	.4867	.659	.163	.117	-.075	.076	.098
11	.0776	.3686	.471	.336	.143	.109	-.003	.184
12	.0590	.5575	.657	.284	-.061	.046	.207	.141
13	.0512	.3059	.374	-.231	-.312	.127	.031	-.018
14	-.0347	.1335	.197	-.225	-.171	.065	.098	-.132
15	-.0456	.1499	.296	.109	-.145	-.045	.162	-.003
16	-.0683	.2829	.512	.098	.025	-.089	.049	.087
17	-.0990	.2244	.334	-.191	.168	.002	-.221	-.094
18	-.1161	.1245	.261	-.176	.022	.045	-.151	.039
19	-.1371	.4007	.511	.210	.258	.075	-.154	-.067
20	-.1682	.2909	.363	-.299	-.209	.161	-.049	.137
21	-.1896	.4049	.610	-.068	.064	-.026	-.156	-.020
22	-.2203	.2972	.369	-.387	-.041	.095	.027	.106

TABLE 5

Factors Rotated to Varimax Criterion

Variable	Factors 1	2	3	4	5
1	.103	-.092	.093	-.534	-.223
2	.277	-.140	.158	-.456	.131
3	.271	-.379	.109	-.125	-.112
4	.372	-.395	.125	-.027	-.260
5	-.048	-.005	.477	.019	-.031
6	.127	-.116	.574	.040	-.087
7	.446	-.214	.053	-.099	-.226
8	.528	.023	-.103	.020	-.077
9	.572	-.187	-.162	.030	.089
10	.653	-.084	.161	-.095	-.136
11	.562	.060	.047	.159	-.138
12	.727	-.144	.073	.041	.071
13	.190	-.519	-.020	-.031	-.017
14	.058	-.343	.074	-.051	.059
15	.332	-.120	-.008	-.059	.143
16	.478	-.110	.029	-.117	-.168
17	.146	-.170	.132	-.087	-.387
18	.101	-.225	.057	-.045	-.241
19	.510	.037	.100	.093	-.349
20	.131	-.509	.041	-.009	-.112
21	.453	-.256	.090	-.120	-.334
22	.104	-.457	.226	-.085	-.139

TABLE 6

The Six Graphically Rotated Orthogonal Factors
(Decimal points omitted)

Test Variable	A	B	C	D	E	F	H^2	Test Variable
1	-01	03	16	57	08	-01	3580	1. Little Pink Tower
2	13	17	-13	48	18	13	3424	2. Three-cube pyramid
3	35	19	19	21	11	08	2573	3. Six-cube pyramid
4.	34	14	37	15	16	27	3931	4. Hidden figures (total score)
5	-05	-01	07	-02	48	-05	2408	5. Fist and thumb
6	06	16	18	00	55	00	3641	6. Thumb and finger opposition
7	20	31	29	21	04	24	3235	7. Round things
8	02	22	11	05	-06	52	3374	8. Ambiguous forms, ideas (total score)
9	27	20	00	05	-07	58	4567	9. Ambiguous forms, elaborations (total score)
10	11	54	21	21	12	32	5087	10. Action agent, number of replies
11	00	55	20	-06	03	26	4146	11. Agent action, number of replies
12	25	62	03	07	05	38	5596	12. Agent action, number of elaborations
13	52	06	09	11	03	10	3051	13. Copy star
14	33	-07	02	09	15	09	1529	14. Copy diamond
15	18	22	09	10	02	22	1477	15. Stick test, production
16	12	38	21	21	01	23	3000	16. Food naming
17	07	03	42	17	12	10	2355	17. Block sorting, relations
18	16	07	28	11	04	-01	1227	18. Block sorting, flexibility
19	-05	33	40	02	07	37	4136	19. Word meaning
20	48	13	22	09	03	06	3083	20. Figure completion
21	20	27	41	25	08	26	4175	21. Directions
22	40	13	24	16	21	-10	3142	22. Stick test, matching

The significantly loaded items are underlined.

Factor B - Divergent Production of Semantic Units (DMU)

.62	12	Agent ction, no. of elaborations (F.38)
.55	11	Agent ction, no. of replies
.54	10	Action Agent, no. of replies (F.32)
.38	16	Food naming
.33	19	Word meaning (F.37; C.40)
.31	7	Round things
(.22	15	Stick test, production (F.22)

Hyperplane: 1, 5, 13, 14, 17, 18

Here, clearly, is ideational fluency in the classic form. It is simply the Ability to produce a variety of ideas in words. In the hyperplane are representatives of cognition (1, 17, 18) and convergent figural production (13, 14).

The longitudinal potential of this factor is suggested by the univocal loadings of Food naming and Round things, both close relatives of ideational fluency (DMU) tests for older children and adults.

Factor C - Cognition of Semantic Systems (CMS)

.42	17	Block sorting, relations
.41	21	Directions
.40	19	Word meaning (F.37; B.33)
.37	4	Hidden figures (A.34)
(.28	18	Block sorting, flexibility)

Hyperplane: 5, 9, 12, 13, 14, 15

The familiar label general reasoning seems a useful name for this constellation of tasks. Following complicated directions and seeing relational alternatives are typical representatives.

It is significant that verbal fluency (9, 12) is represented in the hyperplane. Evidently Word meaning at this age draws on productive, as well as cognitive abilities as shown by its loadings on Factors B and F, not an unreasonable description of vocabulary learning.

Factor D - Convergent Production of Figural Units (NFU)

.57	1	Little pink tower
.48	2	Three-cube pyramid

Traditionally this pair of tasks has had the label of Convergent Production of figural units. Another meaningful label could be Speediness in Spacial modeling. It is to be noted that both of these test items are scored in terms of time for completion, and are the only test items so scored.

The hyperplane of this factor is broad, including representatives of most other factors.

Factor E - Psychomotor Control (small muscle)

.55	6.	Thumb and finger opposition
.48	5	Fist and thumb

Hyperplane: 1, 7, 8, 9, 11, 12, 13, 15, 16, 18, 19, 20, 21

These two items were tentatively judged by us to be maturational in nature. The factor analysis bears out this identification. This is the clearest factor in terms of its separation from the other five in this battery, as its hyperplane includes a representative of each of the other factors.

The appearance of this factor indicates that, although 4-year-olds differ in small muscle control, these differences are unrelated to the so-called "intellectual" differences. The implication is that "readiness" for "intellectual tasks such as those involved in the other factors differentiated in this analysis.

However, even though these manipulative tasks involve largely physical control of fine muscles, they too require mental operations, but not in a differentiating way. Similarly, performance on "intellectual" tasks require motor skills for their execution, yet in this sample those skills, for example, speech, are not differentiating. Nevertheless, it must be pointed out that while many of the test items included in this study are concerned with manipulation of objects, it is obvious from the factor analysis findings that they cannot be simply regarded as purely motor tasks.

Factor F - Divergent Production of Implications (DMI)

.58	9	Ambiguous forms - elaborations
.52	8	Ambiguous forms - ideas
.38	12	Agent Action - elaborations (B.62)
.37	19	Word meaning (C.40; B.33)
.32	10	Action Agent - replies (B.54)
(.22	15	Stick test - production (B.22))

Hyperplane: 1, 3, 5, 6, 14, 18, 20

The separation of this factor from DMU is not as clear as one might hope, but the much larger loadings of the Ambiguous forms measures suggest both more imagination and the presence of an ability for producing figural as well as semantic elaborations. A commonly used name for this factor is originality.

The hyperplane is predominantly representative of factors A and E, both of which require convergent thinking.

The Measurement of Factors in Individual Children

The six factors described above are interpreted to represent specific abilities of young children - abilities which are among the constituents of the overall complex of abilities which we call "intelligence".

In order to determine the significance of a factor in relation to other variables, a means of appraising it in children must be provided. A scoring method must be devised which willyield comparable scores on each of the factors. For our purpose here, factor scores were computed using the formulation recommended by Harman (1960) involving the matrix of test scores for individual children, the inverse of the matrix of intercorrelations of the test item scores, and the factor loadings.

Correlational Analysis of Data

Factor scores on each of the 423 children were computed in preparation for the correlation analysis of our data. Table 7 lists the 12 variables. Table 8 shows descriptive statistics and Table 9 is the correlation matrix, 12 variables.

Table 7

Listing of Variables for Correlational Analysis

Variable

1. Factor A (NFS) Ability to organize spatial systems.
2. Factor B (DMU) Ideational Fluency
3. Factor C (CMS) General Reasoning
4. Factor D (NFU) Speediness in spatial modeling
5. Factor E (NFS) Psychomotor control (small muscle).
6. Factor F (DMI) Originality
7. Age of child coded 0-11 in months past 4 years..
8. Sex of child; boy coded 1; girl coded 2.
9. Area of testing: Phoenix coded 1, California coded 2, and Detroit coded 3.
10. Education of mothers: 9th grade coded 1, high school coded 2, college coded 3.
11. Father's presence in home; daily coded 1, weekends coded 2, occasional visits coded 3; never coded 4.
12. Source: nursery school coded 1, non-nursery school coded 2.

TABLE 8

Means and Standard Deviations of the 12 Variables in the Correlational Analysis

Variable	Mean	Standard Deviation
1	2.702	.709
2	2.395	.752
3	2.523	.724
4	2.255	.826
5	2.706	.833
6	2.281	.742
7	5.494	3.271
8	1.504	.500
9	2.125	.948
10	2.043	.720
11	1.362	.917
12	1.279	.448

TABLE 9

Matrix of Intercorrelations of Variables, Including the 6 Ability Factors

Variable		1(A)	2(B)	3(C)	4(D)	5(E)	6(F)	7	8	9	10	11	12
Ability to Organize Spatial Systems	1(A)												
Ideational Fluency	2(B)	.210											
General Reasoning	3(C)	.170	.097										
Speediness in Spatial Modeling	4(D)	.103	.074	.136									
Psychomotor Control, (S.M.)	5(E)	.038	.146	.195	.074								
Originality	6(F)	.104	.371	.075	.022	-.118							
Age	7	.247	.076	.134	.259	.271	.025						
Sex	8	-.051	-.051	.160	-.026	.062	.043	-.023					
Area of Residence	9	-.326	-.313	.018	.031	.039	-.429	-.058	-.028				
Mother's Education	10	.035	.118	.339	.162	-.039	.141	-.158	.013	.016			
Father's Presence	11	-.052	-.073	-.096	.049	.032	-.034	.043	-.041	.021	-.181		
N.S. - Non N.S. Attendance	12	.195	.172	-.058	-.009	-.033	.181	.093	-.047	-.488	-.256	-.061	

If r is greater than .096 it is significant at probability less than .05
If r is greater than .126 it is significant at probability less than .01
If r is greater than .137 it is significant at probability less than .005
If r is greater than .160 it is significant at probability less than .001

The main purpose of the correlational analysis was to bring to light any relationships that might exist between the selected classificatory variables and the ability factors. As Table 10 shows, of the 66 correlation coefficients 14 are significant at less than the one percent level of confidence.

Sex

The relationships of sex (variable 8) to factor scores are not substantial; the sex differences noted in older children, particularly that suggesting that girls are more fluent than boys, would seem to have their inception after the child is five years old. In fact, the only statistically significant relationship with sex suggests that girls do better than boys at general reasoning (variable 8 with variable 3, $r = .160$) A correlation of this magnitude is of no practical significance. It is clear that separate norms for boys and girls of 4 to 5 years are not necessary.

It is interesting to note in connection with sex differences that in replying to "What can you do with a knife?" (Agent Action, Question 4) a surprising number of children gave answers involving aggression toward other persons (see Table 10). For example: "You can cut people's heads off." "You stick the knife in people and kill them." "Kill somebody" "Kill bad guys". There were 25.6% of such replies for the total of 426 children, but this includes 36% of the boys and only 15% of the girls. The sex difference is significant ($X^2 = 25.67$; $p < .001$).

TABLE 10

Number of Children Giving Aggressive Responses to "What can you do with a knife?" (Test Item 10, Question 4)

	All Children			Boys			Girls		
Mothers Education	N	Aggressive Responses No.	%	N	Aggressive Responses No.	%	N	Aggressive Responses No.	%
Elementary	102	32	31.4	50	29	58.0	52	3	5.8
High School	205	55	26.8	102	30	29.4	103	25	24.3
College	119	22	18.5	59	17	28.8	60	5	8.3
Total	426	109	25.6	211	76	36.0	215	33	15.3

Comparing the three groups of subjects based on mothers' education, the general trend was in the direction of a decrease in aggressive responses with increase in education of mother. In the case of the girls, however, this trend did not hold. Only 5.8% of the elementary education groups, as compared with 24.3% of the high school group, gave aggressive responses. The percentage at the college level was only 8.3%,

Clearly the girls in general, who gave 47% of the total answers to this question, found less aggressive things to do with a knife. The influence of television and movies can be suspected as a prime cause of

the aggressive responses. Certainly there seem to be few children who do not have television in their homes and few who do not do indiscriminate viewing. Most children, no matter how much or how little education their parents have acquired, have more or less frequent opportunities to see movies. It is not directly evident why the girls whose mothers are high school graduates should be more aggressively inclined with knives than the girls whose mothers are of the eighth grade and college graduate level.

Age

If one were to expect chronological age to make a sizeable contribution to differentiation of children's factor scores, the general pattern does not bear out such an expectation. Inspection of Table B in the Appendix II (where cumulated frequencies of factor scores are presented for each of the twelve age groups), will show the progression of means of factor scores having significantly non-zero correlations with age (see Table 10). To find individual frequencies at a specific score level for a specific age, one may subtract the appropriate cumulated frequencies. For example, in Table B (appendix II), at the level of scores from 2.00 to 2.99 on Factor A at age 4-1, there are 28 - 8 = 20 children. Individual frequencies could be cumulated across age levels, and this would be the proper procedure were one to predict "factor age" from factor score. However, the value of the correlation between score and age would not change noticeably. In view of the low values already obtained, such an investment does not seem worthwhile.

Perhaps the most interesting outcome of the comparisons of factor scores with age is that the relationship is much less (and insignificant) for Factor B (Ideational fluency) and Factor F (Originality), the two divergent thinking abilities, than for the two convergent abilities. (A and D), and psychomotor control (E), all statistically significant (r's of .247, .259, and .271 respectively). This finding indicates an increase in convergently productive thinking, along with the maturation of fine muscular control, even within the narrow age range of 12 months, with no evidence of concurrent growth in divergently productive thinking ("ideational fluency" and "originality"). The implication here appears to be that the socializing influences of the 4-year-old's environment are generally not conductive to growth in spontaneity and originality.

Education of Mother

Presumably one of the most important features of the 4-year-old's environment is his mother and his relationships with her. Since he normally spends much of his waking time in her care and under her control, the quality of verbal communication and interaction between him and his mother is presumed to be a crucial influence upon his general cognitive development.

As indicated earlier, one of the criteria in the selection of our young subjects was the education level of their mothers (25% at elementary school, 50% high school, and 25% college graduate). The correlations of this variable with the ability factors are given in Table 9.

Factor C (General reasoning) is most related to mothers' education, while Factors, B, D, and F also yield correlations significantly greater than zero. All these factors seem to be related to child behavior in which mother could easily become involved at an intellectual level. It may be that better educated mothers tend to expose their children more to thinking tasks.

In this connection the possibility of a genetic component cannot be put aside, although one would need to explain why a genetic influence was not as effective for Factor A performance as for the others. However, as with age, the correlation values although statistically significant, are too small to support confident prediction.

Table C in the appendix contains the cumulated frequencies of factor scores within the three categories of education of mother.

Area of Residence and Nursery School Attendance

It will be noted that nursery school attendance was not used as a criterion in the selection of subjects. It turned out, however, that 305 (72%) of the 426 children were attending nursery school at the time they were tested. The correlation of -.488 (Table 10) between areas of residence and nursery school attendance reflects the fact that the majority of the nursery school children were in the Detroit portion of our sample.

Among the highest of the correlations shown in Table 9, are those of area of residence with three of the ability factors (A, B, and F). These coefficients, negative in sign due to the way area was coded for correlations (see Table 7), indicate that those factor scores tended to be higher for the western, than for the midwestern sample. It is impossible to account for these "area" differences with the data at hand. There are, of course, a number of possible bases for these results. The testing, for example, was done by different individuals in the two areas. In the Detroit area the great bulk of the testing was done by one person. In the Phoenix-California area as many as seven people did the testing. In both areas, however, the testing was done by competent, well-trained persons. Another possibility is that the correlations represent real group differences in the children from the two areas. With the exception of the "elementary education" segment of the sample, the majority of the Western children were of the University Community of Tempe, and of relatively affluent and "privileged" areas of California, whereas the Detroit sample tended to be more cosmopolitan in nature. At any rate, the three significant correlations show "superior" performance on the part of the western sample on tests of ability to organize spatial systems, ideational fluency, and originality.

A Search of Evidence of Thinking Types

A study was made of ability-pattern similarities in our sample

of children with the purpose of looking for evidence which would support the concept of thinking "types" in children.

A "Q" type analysis was utilized for this purpose. In Q-methodology the individuals become the "variables" and the test-item scores become the "population". Correlations among individuals are computed.

In this instance, 31 children were selected on the basis of their profiles of "quick scores"[1] on three ability factors: cognition of semantic systems (general reasoning), ideational fluency, and convergent production of figural systems (ability to organize spatial systems). While it would have been possible to select children in terms of their profiles on the six ability factors presented earlier, such a selection would have reduced the present aspect of the study to a mere demonstration. Scores of the 31 selected children on the six final factors are presented in Table 11.

The selected children were first assigned to five small groups in terms of their three-score profiles. Finally all 31 children constituted Group VI. Table 12 shows the location of each child by ability profile and group in terms of the number 1 to 31 which were arbitrarily assigned to the children.

In the profiles the order of the three letters identifies the abilities as follows: The first letter in every instance represents cognition of semantic systems, the second letter always represents ideational fluency, and the third letter represents convergent production. The particular letter (A or B or C), on the other hand, indicates the child's quick-score classification on an ability factor: A always means an upper quartile rating, B always means the child's performance placed him in the middle half of the group and C always indicates the lower quartile. For example, the profile CAB applies to a child who is in the lower quartile on cognition of semantic systems, in the upper quartile on ideational fluency, and in the middle half on convergent production in figural context. Table 13 summarizes the composition of the profile-type groups, and the meanings of the quick score profiles.

The Q-Analysis Findings. The children (variables) of each of the six groups were intercorrelated and the correlational matrix in each case was factor analyzed. Tables 14 and 15 present the rotated factor matrixes of Groups I and II. It will be noted that these two groups were identical as to quick score profile conformation.

In Group I, two factors were clearly identifiable as profile-type ABC and profile-type BCA, but the persons selected for type CAB did not stay together. In Group II, however the profile-types BCA and CAB, but not ABC, were supported by obtained factors. In both groups, then, the obtained factors supported profile types. The two representative persons in each case, of course, correlated higher with each other than with any other persons in the group.

In a similar pattern Groups II and IV each had representatives of profile types (Tables 16 and 17). In Group III profile-types BAC and CBA were supported by obtained factors. In Group IV all three profile-types were clearly supported by the three obtained factors.

[1] See below for explanation of "Quick Score".

TABLE 11

Scores on Six Final Factors for 31 Children Selected For Q Analysis

Var.	Profile	Factor A	Factor B	Factor C	Factor D	Factor E	Factor F
1	ABC	1.492	2.545	3.174	2.668	1.972	2.412
2		2.041	2.475	1.548	2.317	1.100	3.539
7		1.590	2.342	3.095	3.722	.912	2.207
8		2.345	2.677	1.101	2.047	3.110	3.603
25		1.622	2.450	3.011	1.063	2.851	3.148
3	BCA	3.677	2.476	2.904	1.360	3.448	1.857
4		3.020	.815	3.262	2.656	2.249	1.703
9		2.591	2.327	3.464	3.425	3.467	.882
10		2.966	1.576	3.541	1.125	3.036	1.092
5	CAB	3.101	3.784	2.021	2.350	2.390	1.873
6		2.377	2.865	.796	2.639	2.139	1.029
11		2.674	2.522	1.621	2.823	2.178	2.959
12		2.597	3.248	1.883	.869	1.975	2.286
26		2.482	3.293	2.138	1.159	3.220	2.106
27		3.965	2.095	.593	3.120	3.372	2.486
28		3.161	3.271	2.084	2.064	1.946	3.418
29		2.302	3.062	1.527	3.830	3.475	2.634
13	ACB	2.800	2.524	2.714	2.090	.469	2.603
14		2.735	2.691	2.206	2.400	3.259	2.906
19		1.677	2.033	2.654	1.714	3.193	3.097
20		2.444	2.432	3.099	1.653	3.655	2.270
15	BAC	2.204	3.669	1.639	1.910	3.383	2.230
16		1.699	2.923	2.651	1.283	3.281	2.426
21		1.942	3.422	1.287	2.373	2.036	2.190
22		2.272	3.219	1.878	1.779	1.969	3.830
30		1.616	2.426	1.936	1.782	3.141	3.145
17	CBA	3.643	2.927	3.055	.682	3.167	.935
18		3.182	1.522	2.317	2.839	3.683	1.531
23		3.934	2.288	2.582	2.815	3.454	.837
24		3.839	2.555	2.333	1.405	3.352	.805
31		4.399	1.135	2.636	1.291	3.270	.671

ABC should be highest on Factor C, moderate on Factor B, and low on Factor A. Discrepancies between Quickscore profile and the Factor scores derive from selection of tests and greater precision in the Factor scores.

TABLE 12

Location of children by ability profile and group

Profile & Ident. No.	I	II	III	IV	V	VI
ABC- 393	1					1
379	2					2
398		7				7
133		8				8
192					25	25
BCA- 470	3					3
390	4					4
452		9				9
486		10				10
CAB- 287	5					5
465	6					6
164		11				11
105		12				12
104					26	26
185					27	27
271					28	28
295					29	29
ABC- 127			13			13
305			14			14
329				19		19
340				20		20
BAC- 297			15			15
324			16			16
334				21		21
278				22		22
139					30	30
CBA- 492			17			17
227			18			18
293				23		23
155				24		24
458					31	31

TABLE 13

Assignments to Groups by Standing in the Six Profile Types, with Profile Descriptions

Children (Variables)	Code	Description
1, 2, 7, 8 25	ABC	Cognition of Semantic Systems - upper fourth Ideational Fluency - middle half Convergent Production in Figural Context - lower fourth
3, 4, 9, 10	BCA	Convergent Production in Figural Context - upper fourth Cognition of Semantic Systems - middle half Ideational fluency - lower fourth
5, 6, 11, 12, 26, 27, 28, 29	CAB	Ideational Fluency - upper fourth Convergent Production in Figural Context - middle half Cognition of Semantic Systems - lower fourth
13, 14, 19 20	ACB	Cognition of Semantic Systems - upper fourth Convergent Production in Figural Context - middle half Ideational Fluency - lower fourth
15, 16, 21 22, 30	BAC	Ideational Fluency - upper fourth Cognition of Semantic Systems - middle half Convergent Production in Figural Context - lower fourth
17, 18, 23 24, 31	CBA	Convergent Production in Figural Context - upper fourth Ideational Fluency - middle half Cognition of Semantic Systems - lower fourth

TABLE 14

Rotated Factor Matrix, Group I - Q-Analysis

Child	Profile	1	2	3
1	ABC	-.205	-.124	-.760
2	ABC	.152	-.045	-.531
3	BCA	.562	-.558	-.228
4	BCA	-.124	-.841	-.088
5	CAB	.830	.213	-.247
6	CAB	.181	-.028	-.313
			BCA	ABC

TABLE 15

Rotated Factor Matrix, Group II, Q Analysis

Child	Profile	1	2	3
7	ABC	.099	.064	-.438
8	ABC	-.987	.507	-.026
9	BCA	.534	-.125	-.520
10	BCA	.669	.010	-.147
11	CAB	.212	.556	-.101
12	CAB	.298	.585	.075
		BCA	CAB	

TABLE 16

Rotated Factor Matrix, Group III, Q-Analysis

Child	Profile	1	2	3
13	ACB	-.021	-.131	.558
14	ACB	.423	-.038	.199
15	BAC	.749	-.025	-.210
16	CBA	.887	.180	-.012
17	CBA	.394	.498	.159
18		-.128	.673	-.313
		BAC	CBA	

TABLE 17

Rotated Factor Matrix, Group IV Q Analysis

Child	Profile	1	2	3
19	ACB	.717	.000	.364
20	ACB	.700	.177	.122
21	BAC	.099	-.038	.609
22	BAC	.396	-.236	.718
23	CBA	-.315	.656	-.056
24	CBA	.153	.760	.138
		ACB	CBA	BAC

TABLE 18

Rotated Factor Matrix, Group V, Q-Analysis

Child	Profile	1	2	3
25	ABC	.716	-.159	-.044
26	CAB	.602	-.074	.183
27	CAB	-.139	.734	.273
28	CAB	.428	.143	.010
29	CAB	.100	.769	-.125
30	BAC	.804	.426	-.070
31	CBA	.150	-,162	.893
			CAB	CBA

Group V consisted of 7 children, 4 of whom were selected to represent profile-type CAB and one to represent each of the profiles ABC, BAC, and CBA. The rotated factors for this group are shown in Table 18. It will be noted that profile CBA, represented by child 31, separated to form its own factor (Factor 3), while BAC joined with representatives of CAB (children 26 and 28), and with ABC to constitute Factor 1. Factor 2 contains the other two representatives of profile CAB. Profile CAB thus separates into two factors in the analysis of Group V.

Finally the 31 selected children were combined in a single analysis. The results of this analysis are presented in Table I in the appendix.

In this analysis the number of factors was specified as six because of the six profiles. This number may have been in error, as the profiles could be grouped logically into three bipolar pairs: ABC-CBA; BCA-ACB; and BAC-CAB. On the other hand, the results of the principal components calculation indicates a strong probability of five or six components, and there appear to be no really marked bipolarity among groups of profiles in the correlation matrix.

Six principal components were rotated to the varimax criterion. The lowest loading considered for interpretation was .50, based on the estimated standard error of a coefficient of correlation. Three fairly clearly identifiable factors, one for each of the profiles ABC, BAC, and CBA were found as listed in Table 19. It is of note that ABC and CBA, although 'logical' opposites, show up as orthogonal factors. The profile BCA-ACB is not dominant in any of the obtained factors. Three of the factors are unclear and are not interpreted.

The Six Quickscore Profile-types Examined in Relation to their Representative Children's Scores on the Final Factors.

An examination of the factor-score patterns of the representatives of each of the six quickscore profiles may be of interest. These relationships are presented in Table 12 above.

Profile ABC (High in cognition of semantic systems, Average in ideational fluency, low in convergent production). In terms of factor scores, these children were low in ability to organize spatial system (A), somewhat higher in ideational fluency (B) varied in general reasoning (C), average or above in speediness in spatial modeling (D), varied in psychomotor control of small muscles (E); and high in originality (F).

Profile BCA (Average in cognition of semantic systems, low in ideational fluency, high in convergent production). In terms of factor scores, this "type" of child showed high ability in spatial organization of systems (A). They were low to average in ideational fluency (B), had good ability in general reasoning (C), varied in capacity for motor speed (D). They had excellent psychomotor control (E), but were relatively low in originality (F).

17 and 18. Block Sorting

Item 17 deals with relations, and 18 deals with flexibility. Materials: four sets of blocks, a circle, square, triangle and diamond. Each set graduated in size, and in color, pink, blue, green and yellow, making 16 blocks altogether. They are in two boxes, with covers.

Directions: Say "Here are some pretty blocks." Place the boxes and their covers in a row. Select the largest block of each shape and place one in each box or cover. Spread the other blocks indiscriminately in front of the child saying, "Put all the rest of these blocks in the boxes where they belong."

Record whether the child sorts first by color or shape and degree of success. Then remove the blocks, repeat with the same starting blocks and say, "Now, do it a different way." If he starts to repeat the same sorting method, say, "No, do them a different way." If he is confused and does not understand, say, "Let me give you a hint," and place the second row of whichever category he is expected to do. Record his degree of success on whether he repeats his first method of sorting. If the child has a comprehension of the sorting task, then the third type of sorting may be tried, involving size.

Empty boxes again, and this time place each square block in a separate box. Say, "Now put all the blocks in the boxes where they belong." Check choice of sorting category and record the number of blocks correctly placed in each box.

There are two types of scoring involved here. Test Item No. 17 is the score of sorting relations. Is the child able to get the idea of sorting either by color, shape, or size. No. 18 is a measure of how flexible the child is. This score is the total of the different methods of sorting used. If he sorts by only one method, his score is 1, if by both color and shape it is 2, and if happily he also sorts by size, his score is 3.

19. Word Meaning

A series of the following ten questions comprise this test.

1. What is this? (Pencil) Hold the pencil out in front of the child.
2. What is it for?
3. What is this? (Chair) Examiner puts her hand on the back of the child's chair, making sure that it is the chair itself that is meant.
4. What is it for?
5. What is this? (Show horse)
6. What is it for?
7. What is this? (Show dog)
8. What is it for?
9. What is a house for?
10. What is a clock for?

Profile CAB (low in cognition of semantic systems, high in ideational fluency average in convergent production). The factor scores of these children showed mostly excellent ability in spatial organization (A). They were verbally fluent with many ideas (B), but they were poor reasoners (C). Some were high and some were average in speed of spatial modeling (D). Most of them were about average in psychomotor control (E), and they showed an average degree of originality (F).

Profile ACB (high in cognition, low in ideational fluency, average in convergent production). The group with this profile tended to be average in spatial organization (A), average in ideational fluency (B), somewhat superior in reasoning ability (C), low average in speediness of performance in spatial tasks (D), above average in psychomotor ability (E), and somewhat superior in originality (F). They were on the whole a fairly evenly balanced, average group.

Profile BAC (average in cognition of semantic systems, high in ideational fluency, low in convergent production). These children were generally low average in factor scores in organizing spatial systems (A). They were excellent in verbal fluency and produced a variety of ideas (B), but their reasoning was poor (C). Some of them were speedier than others in spatial modeling (D). Their psychomotor control was mostly superior (E), and they also tended to be superior in originality (F).

Profile CBA (low in cognition of semantic systems, average in ideational fluency, and high in convergent production). The group of children representing this profile were similar in certain respects, but different in other respects, than those of profile BCA. These children ranked high in spatial organizing ability (A), low average, rather than low in ideational fluency (B), and somewhat less superior in reasoning, but still relatively high (C). They were generally average in speediness in spatial modeling (D), and, like the BCA group, they were high in psychomotor ability (E). They showed even less originality (F) thus ranking very low in this factor.

These ability-type patterns and relationships may be summarized by means of the following scheme for representing dominant factor score ratings of the Quickscore profile groups.

Very high rating	+++	Low average	--
Superior	++	Very low	---
Average	+-	Mixed	M

Quickscore Profile Group	Factor A	B	C	D	E	F
ABC	---	++	M	+-	M	+++
BCA	+++	---	+++	M	+++	---
CAB	++	+++	---	M	+-	+-
ACB	+-	+-	++	--	+++	++
BAC	--	+++	---	---	++	++
CAB	+++	--	++	+-	+++	---

As further work is carried out in this type of analysis it should be possible to gain valuable insights into the types of thinking in which a child is strong or weak. Clues as to educational and environmental experiences and needs can be gained. Help can be given to parents, teachers, clinicians, and social workers, where they may be of value not only in diagnosis but in planning for the child's future. While it may not be possible or desirable to produce similarity in pattern for all children, yet surely the balancing of abilities is worthy of effort. There were children of this balanced type in our study, but they were eliminated in the selection of types for the profile analysis. Children who are weak in general reasoning can presumably be strengthened in that area by educational devices developed for that purpose Children who are inadequate in their spatial perception could be given opportunities for developing greater power in that direction. Furthermore, the study of a group of children should reveal if they are lacking in divergent abilities because of environmental lacks.

It will be interesting to compare these four year olds in terms of patterns with their retests at age five, which is included in our next projected research.

Conclusions and Implications

As was stated early in this report relatively little reported research has been concerned with the identification and measurement of ability factors (Guilford model) in children at the preschool levels. The present research has clearly shown that at least 6 specific "mental" abilities have become differentiated in children generally by age 4 years.

These abilities were identified as belonging to three different categories of "operations." In the convergently productive category are the ability to organize related units into spatial systems, and the ability to reproduce with dispatch models from concrete elements (speediness in spatial modeling). In the divergently productive category, "thinking" in the sense of a free flow of relevant ideas (ideational fluency), and "originality" were identified. In the cognitive domain is the ability to perceive relationships among parts, and to understand and to follow directions (general reasoning ability). The sixth ability, which is judged to depend largely upon the child's general level of maturation, is the psychomotor control of the fine musculature. Thus we conclude that these 6 factors are among the "thinking" facilities of 4 to 5 year-old children, and that these abilities can be appraised in individual children by means of the set tests described in this report.

On the basis of evidence derived from our data by use of a "Q" methodology, we conclude that 4 to 5 year-old children generally can be classified roughly into "types" in terms of their ability profiles.

Among the interesting outcomes of this research are the findings relating to the development of certain of the abilities tested. First, the only ability factors that are significantly ($p < .005$) related to age-at-testing were the two convergent production factors. Thus, within the 12

month age range there is no substantial evidence of growth in ideational fluency, "originality" and general reasoning, while there is some evidence of increase in the abilities which required concentration upon reaching specific ends, copying specific models, following directions. None of the relationships are large enough to warrant discussing a "factor age" analogous to the familiar "mental age".

The second finding related to the development of certain of these abilities was the relationship between them and the educational level of mother. There was evidence of a slight trend toward higher scores in general reasoning, originality, and speediness in spatial modeling in children of mothers with higher levels of education. The evidence, of course, is not conclusive, but the suggestion is that the preschool environment in the American culture generally does not provide optimum stimulation for the development of flexibility, spontaneity and originality of expression. Socialization tends rather to emphasize the importance of giving the "right" answers, following directions, copying models. The second suggestion is that parent education; and particularly education concerning the developmental needs of children, can be an important factor in early intellectual development.

As was stated in the beginning of this report, much of the attention of child development researchers is being centered upon the problems of adequate and appropriate stimulation in infancy and early childhood. Evidence is accumulating which supports the view that the development of intelligence is not just a matter of maturation - the natural unfoldment of the genetically given - but rather that environmental stimulation is an extremely important factor in its development particularly during the early months and years of life. The findings of this project support this point of view.

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APPENDIX I

Directions For Administering The Test of Thinking

The testing should be done at a little table with small chairs. The child should be seated so that his elbows are even with the table. The examiner should sit opposite the child and see that the test materials are placed so that the child can manipulate them easily. The room where the testing is done should be as free as possible from distracting objects, such as toys, and from distracting noises. For 4-year-old. children it is usually best that no observers, such as parents or other children, are to be present in the room.

The examiner should talk freely with the child and use various verbal devices to challenge his interest. It is permissable at times if there is a tendency toward negative or inattentive behavior to use small pieces of candy such as M & M's or gum drops as rewards. The tests should be called "games" and should be presented as "surprises" and with a calculated intent to intrigue the child's curiosity.

The Face Sheet will be filled in as far as possible beforehand by the Coordinator, but the Examiner is responsible for seeing that it is completed. As much detail as possible is to be recorded about the child's performance and reactions to the test. All verbal responses should be recorded completely. The order of tests may be varied if it seems desirable to introduce one that has much appeal, if the child's interest seems to be lagging. However, a record should be made of such changes in sequence.

No scoring should be attempted by the Examiner. The important thing is a complete and accurate record. As soon as possible after a child has been tested, the completed test record should be returned to the Coordinator.

If the child has a bad cold or shows other symptoms of not feeling well, the test should not be begun, or, if started, should be discontinued.

Directions for the Specific Test Items:

1. Little Pink Tower

Materials: Five pink blocks varying in size from 3/8" to 2".

Build the pink tower behind a screen, and then place it in front of the child. Then say, "See this pretty pink tower? See how it is built with the biggest block at the bottom, then the next biggest, and on up to this little baby block at the top. Do you think, if I knock the tower down, you can build it again just the same way, with the big block on the bottom, and the little block on the top." Whatever the response, knock the tower down, taking care to have the blocks near together in easy reach and thoroughly mixed.

Recording: If the tower is not built correctly, record result as failure and simply record "OK" if order is correct. Start timing when the child picks up the first block and stop time when the last one is placed. Describe any further adjustments he may make. When he stops, ask, "Are you finished?" Record time only if the result is correct.

2. Three-cube pyramid.

Materials: Box of 12 unpainted, one-inch cubes

With three of the cubes, build a pyramid on the table directly in front of the child. This consists of two blocks slightly separated with another resting on the two, evenly covering the open space. Enough room is left between the model and the edge of the table for the child's copy. Say as you work, "See what I am making? I wonder if you can make one just like it? Make it out of these and make it right there, "first pointing to the other three blocks that are placed on the table to the child's left and then to the space immediately in front of the child. Start the stopwatch as soon as the child picks up one of the cubes to start his building. Do not permit the child to destroy the model pyramid if it can be avoided. Say emphatically, "No, you make one like this. Make it out of these, right here," pointing out again what the child is to do. Stop the watch as soon as the child has achieved a pyramid, whether or not he has removed his hand from it. Record the time only if the result is correct.

3. Six-Cube Pyramid Directions

With six of the cubes, build 3 in 1st row, (½ inch apart) 2 on top of these in the second row, and one on top. Say, "Now see what I am going to make this time, a bigger one. I wonder if you can make one like this? Make it right here, out of these," (pointing to the space in front of the child and the remaining cubes). "Make it just like this one." Do not permit the child to tear down the model if this can be avoided. Record the time only if the pyramid is built correctly. Record comments and other observations that can be made of this performance.

4. Hidden Figures

Materials: Three pictures: (1) Mary's kittens, (2) mamma rabbit, and (3) bouncing or play balls on the grocery store shelves.

Place picture #1, Mary's kittens, directly in front of the child, saying, "Here is a picture of Mary. She has some kittens. She has lost her kittens. Look all over the picture to see if you can find her kittens."

Praise may be given for correct responses. Such as, "That is good. Now find some more kittens," encouraging the child to examine the picture carefully.

Have child put his finger on the parts he identifies as kittens. If you are not sure of his identification, insist that he show you the kitten by putting his finger directly on it. Count number of correct

identifications and record. If he points to the same object more than once, do not count it.

Even if the child fails picture #1, repeat the procedure for picture #2, mamma rabbit, saying, "Here is a picture of mamma rabbit, The baby rabbits are hiding from mamma rabbit. See if you can find them for her."

Repeat again for picture #3, grocery store pretty balls, saying, "In this grocery store there are some bouncing balls hidden among these groceries. See if you can find them." In each case, record only the number of objects correctly located.

5. Fist and Thumb

Directions: Place your right hand in front of the child, resting your elbow on the table, When you are sure of the child's attention, close your hand, holding the thumb straight up, and say, "See how I can make my thumb wiggle? Now, first shut your hand just as I do, Now see if you can make your thumb wiggle like mine." Record the hand used by the child and the degree of success. No credit if fingers move with thumb.

6. Thumb-Finger Opposition

Directions: Face in the same direction as child is facing, so that, when you extend your right hand, it is in the same relative position as the child's right hand. While you spread your fingers wide apart, holding your hand with the palm facing the child, say, "Now watch me and see if you can do this. Hold your hand out like this and keep your fingers wide apart." See that child spreads his fingers properly. Then say, "Now touch your thumb to each finger this way." Demonstrate several times. "Now you do it." Three trials may be given. Record the degree of success, remembering that only the touching of all four fingers in succession with the fingers spread apart is credited as success.

7. Round Things

"Do you know what things are round? Tell me some things that are round." Urge the child to give more answers. Record all responses whether correct or not giving exact wording. Score is number of correct answers.

8. Ambiguous Forms - Ideas

Materials: Three ambiguous form cards.

Hand Form 1 directly to the child with the number in his lower right hand corner. Ask, "What is this?" Record whatever he says. Then ask, "What else can you see?" and urge him repeatedly for further responses by asking, "Can you see anything else?" Record verbatim everything the child says. Repeat this procedure for each of the other two cards. This test is scored in two ways, in terms of separate ideas involving the whole object. The total number of these mentioned is used as the score of ideas.

9. Ambiguous Forms - Elaborations

The extra items mentioned such as "It has a horn sticking out," or "Here is a handle" or other discussions and elaborations in regard to the objects named are recorded for each card and totaled for an elaboration score.

10. Action Agent Test

Materials: Six action questions: (1) "What runs?" (2) "What bites?" (3) "What melts?" (4) "What stings?" (5) "What explodes? (6) "What smiles?"

Method: Ask the child, "What runs?" Whether or not he answers correctly, give him some more answers, like "boys," "girls," "dogs," etc. Then proceed with other action questions. If he gives only one or two answers in each case, urge him to continue. Record all replies for each question. If the child does not know an answer to the first questions, continue for at least three other action questions before discontinuing. The score is the number of correct replies for all six questions.

11. Agent Action, Number of replies

Ask the following five questions with a supplementary question for each.

1. What can you do with a ball? What else can you do with it?
2. What can you do with a wagon? What else can you do with it?
3. What can you do with a piece of paper? What else can you do with it?
4. What can you do with a knife? What else can you do with it?
5. What can you do with a bottle? What else can you do with it?

If the child cannot give an answer to the first question, give two illustrations such as "you can throw it" and "you can roll it." In each case, keep asking, "What else?" until the child gives no more answers.

Record in detail all the child's answers. Ask all five of them even if he fails the ones before. The score for this portion of the test is the number of correct replies.

12. Agent Action - number of elaborations

In the recording of all the child's answers in the above test item, many children will give elaborative details, such as "I can pull my dollie in the wagon, and I can feed her too," or "My mamma cuts potatoes with a knife and then she cooks them." These extra ideas contributed in response to the questions are scored as elaborations. The total number for all five questions is the score for this test item.

13. Copy Star

Materials: A 3" x 3" card with a star (*) drawn on it consisting of three 1 inch lines intersecting each other at angles of 60 degrees.

Method: - Place the paper on which the line is to be drawn in front of the child, placing the card directly above the space on the section of the paper on which the child is to draw. Give him a pencil and say "See how nicely you can make one like this." If he fails on the first try, have him try again. Do not let him draw on the test card. The score is either 0 or 1 depending on whether the child is able to make an acceptable copy.

14. Copy Diamond

Materials: A 3" x 3" card with a drawing in black ink of a diamond with a longer diagonal 1½ inches. The shorter diagonal one inch and all four sides are one inch.

Method: Present the test in exactly the same way as for drawing a star. Try not to be concerned if the child fails either or both of these tasks difficult for a 4-year-old but simply say sympathetically, "That is a hard one to do, isn't it?" The score is 1 or 0 depending on whether the result is a success or failure.

15. Stick Test - Production

This test item is the second half of No. 22, Stick Test Matching and necessarily in administration follows No. 22. An error in programming produced this disarranged order. This portion of the test is designed to test the originality of the child in making stick patterns. Actually it appears in both divergent production factors, Ideational Fluency and Originality with rather low loadings in each. Not only does it evaluate originality but also the child usually names his production. Credit is given both for making an original product and for telling what it is.

The directions are simple: Give the child eight sticks. "Now see what you can make out of these. "Make something different." Then give eight more sticks, encouraging different things. Repeat again. Draw each production. Do not ask what it is, but, if child names it spontaneously, record what he says.

16. Food Naming

Say to the child "Now we are going to talk about food. Tell me all the things that people like to eat." Urge the child to give more answers and record complete responses in order. The score is the number of articles of food named by the child. No credit is given for repetition of the word "food."

17 and 18. Block Sorting

Item 17 deals with relations, and 18 deals with flexibility. Materials: four sets of blocks, a circle, square, triangle and diamond. Each set graduated in size, and in color, pink, blue, green and yellow, making 16 blocks altogether. They are in two boxes, with covers.

Directions: Say "Here are some pretty blocks." Place the boxes and their covers in a row. Select the largest block of each shape and place one in each box or cover. Spread the other blocks indiscriminately in front of the child saying, "Put all the rest of these blocks in the boxes where they belong."

Record whether the child sorts first by color or shape and degree of success. Then remove the blocks, repeat with the same starting blocks and say, "Now, do it a different way." If he starts to repeat the same sorting method, say, "No, do them a different way." If he is confused and does not understand, say, "Let me give you a hint," and place the second row of whichever category he is expected to do. Record his degree of success on whether he repeats his first method of sorting. If the child has a comprehension of the sorting task, then the third type of sorting may be tried, involving size.

Empty boxes again, and this time place each square block in a separate box. Say, "Now put all the blocks in the boxes where they belong." Check choice of sorting category and record the number of blocks correctly placed in each box.

There are two types of scoring involved here. Test Item No. 17 is the score of sorting relations. Is the child able to get the idea of sorting either by color, shape, or size. No. 18 is a measure of how flexible the child is. This score is the total of the different methods of sorting used. If he sorts by only one method, his score is 1, if by both color and shape it is 2, and if happily he also sorts by size, his score is 3.

19. Word Meaning

A series of the following ten questions comprise this test.

1. What is this? (Pencil) Hold the pencil out in front of the child.
2. What is it for?
3. What is this? (Chair) Examiner puts her hand on the back of the child's chair, making sure that it is the chair itself that is meant.
4. What is it for?
5. What is this? (Show horse)
6. What is it for?
7. What is this? (Show dog)
8. What is it for?
9. What is a house for?
10. What is a clock for?

Record the child's exact reply to each question. Ask the questions one at a time in sequence. Hold up a pencil to the child for questions 1 and 2. For 3 and 4, touch the chair on which the child is sitting. Allow time for child to think what he will reply and urge for responses if necessary. The score is the number of questions correctly answered.

20. Figure Completion

A. A partially completed drawing of a block

Place the sheet with the partially completed block in front of the child, with the uncompleted "A" facing him, saying, "Here is a toy block, see if you can finish it. I will draw one line and then you make some more to make it look more like a toy block." Then, with the pencil, complete the line for the upper right-hand corner. Make no marks on the drawing other than the one demonstration line. Allow the child to draw freely whatever he wishes. Do not insist that he draw lines only on the block. Only lines completing the block are scored as correct.

B. Pie completion - a circle with lines drawn from the center to represent a pie with some slices already cut.

Place the paper with the pie completion drawing in front of the child, saying "Let us pretend this is a pie. Let us cut it up into pieces. See, I'll finish cutting this piece. You finish the pieces started and see if you can make some more pieces." Complete the line starting at the center to the edge of the pie. Draw only this one line, leaving the other partially drawn lines for the child to complete. Praise the child as he works and urge him to make more slices. Be careful to preserve the drawing just as he makes it. Do not add any more lines than the one you make to demonstrate. All lines drawn by the child from the center to the circumference of the circle are counted as correct. The score for A and B is the total score for each completion drawing.

21. Directions test

Materials: The four boxes from the nest of cubes and four small cars, colored red, green, yellow and blue.

Part A: Directions: Place the boxes (may be called garages) to one side Select one box and one car for the first four parts of this test item, and place them in front of the child, the car near the child, the box further back, then give the first direction:

1. Put the car on the box.
2. Put the car in the box.
3. Put the car in front of the box.
4. Put the car behind the box.

Each time remove the car and place it in front of the child.

For the directions 5 through 8, the four cars are placed in front of the child in a row, and he is asked to carry out the four color discrimination directions:

5. Show me the red car.
6. Show me the blue car.
7. Show me the green car.
8. Show me the yellow car.

For directions 9 through 11, the boxes are spread out in order of size in front of the child with the largest box to his right, and approximately 2 inches apart. The directions are given in order asking the child to put his finger on the box if he tends to point ambiguously.

9. Show me the biggest box.
10. Show me the littlest box.
11. Show me the box that is almost as big as the biggest box.

Part B: Directions: With the cars and boxes arranged as in above, give the following directions one at a time, recording response and each time returning the car back to its original place before giving the next directions.

1. Put the Green car on the Littlest box.
2. Put the blue car behind the pink box
3. Put the yellow car in the blue box
4. Put the red and green cars in front of the box that is almost as big as the biggest box.

Score is 1 point for each success for both A and B.

22. Stick Test - matching - See test item 15 Stick Tests Production for the second half of this test.

Materials: Small yellow box of 30 sticks. A drawn square, a drawn triangle.

Procedure: (1) Remove the two cards and dump the sticks on the table. Say, "See this box of sticks? See what I make. See if you can make one like this." Make a sample pattern with three sticks as you talk to the child, putting the pattern you build in front of the child. The pattern is two parallel sticks with one stick perpendicular and between the others, an H on its side (I). Draw in the space on record sheet whatever the child makes, using a short, straight line to represent each stick. Then make a pattern like a chair in profile of four sticks (⊓). One point is given for each correct response. Replace sticks into the pile of sticks on the table. In presenting the □ and △ cards, the child may mistakenly copy the rectangular card instead of producing the square. If the △ is produced as another □, examiner should say, "No," and trace the pattern of the △ on the card and say, "Make one like this."

APPENDIX II

TABLE A

Conversion Table for Converting Item Raw Scores to Scaled Scores

Variable No.	Item Name	Scale Values ⟹ 1	2	3	4	5
Factor A. Ability to Organize Spatial Systems(NFS)						
13	Copy Star	0	-	-	-	1
20	Figure completion	0	2	3-4	4-5	6 or over
22	Stick test matching	0	1,2	3	4	5
3	Six-cube pyramid	Failure	181"	31"-180"	15"-30"	1"-14"
4	Hidden figures (Total score)	0-4	5-3	9-12	13,14	15 or more
14	Copy Diamond	-	-	0	-	1
Factor B. Ideational Fluency in words (DMJ) Ability to produce a variety of ideas						
12	Agent Action -elaborations	0	1	2-4	5,6	7 or more
11	Agent Action, no. replies	0-3	4	-	5	6
10	Action Agert no. replies	0-1	2-4	5-8	9,10	11 or more
16	Food naming	-	0-2	3-5	6-8	9 or more
19	Word meaning	-	0-3	5,6	7-9	10
7	Round things	-	-	1	2-4	5 or more
15	Stick test, production	-	0	1	2,3	4 or more
Factor C. General reasoning (CMS)						
17	Block sortin relations	-	0	-	1	-
21	Directions	0-5	6-9	10-13	14,15	16 or more
19	Word meaning	0-3	4	5,6	7-9	10 or more
4	Hidden figures	0-5	6-9	9-12	13,14	15 or more
18	Block sorting, flexibility	0	-	1	-	2 or more
Factor D. Speediness in spatial modeling (NFU)						
1	Little pink tower	60"-F	14"-59"	11"-13"	7"-10"	1"-6"
2	3-cube pyramid	15"-F	8"-14"	7"	4"-6"	1"-3"
Factor E. Psychomotor control (fine muscles)						
6	Thumb-finger opposition	Failure		pass		
5	Fist and thumb	Failure		pass		
Factor F. Originality (DMI						
9	Ambiguous Forms, elaborations	-	0	1,2	3-6	7 or more
8	Ambiguous Forms, ideas	0	1 or 2	3	4,5	6 or more
12	Agent action elaborations	0	1	2-4	5,6	7 or more
19	Word meaning	0-3	4	5,6	8 or more	-
10	Action Agent,replies	0-1	2-4	5-8	9,10	11 or more
15	Stick test, production		0	1	2,3	4 or more

TABLE B

Cumulated Frequencies of Factor Scores by Age of Child

Factor	Score Interval	Age of child in years and months 4-0	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8	4-9	4-10	4-11	All	
A	0-.9	1	0	0	0	0	0	0	0	0	0	0	0	1	Pearson r
	1.0-1.9	7	8	6	5	9	7	6	5	4	5	4	3	69	with age
Spatial	2.0-2.9	22	28	26	24	31	33	31	26	23	14	13	18	289	(coded 00-11)
Systems	3.0-3.9	30	32	30	35	41	41	42	38	33	27	26	29	404	r = 247
NFS	4.0-4.9	0	0	31	0	42	42	43	41	35	31	28	33	423	p .001)
	Mean	2.5	2.4	2.5	2.7	2.6	2.6	2.6	2.8	2.8	3.0	3.0	3.0	2.70	
	S.D.	.79	.61	.68	.67	.75	.68	.69	.79	.75	.93	.84	.83	..71	
B	0-.9	1	3	1	4	1	1	3	4	4	0	2	3	27	Pearson r
Ideation-	1.0-1.9	10	17	5	11	7	7	4	13	8	11	7	7	107	with age
al	2.0-2.9	23	32	25	29	35	36	31	29	30	23	26	27	346	(coded 00-11)
Fluency	3.0-3.9	30	0	31	35	42	42	42	41	33	30	28	33	423	r = .076
DMU	4.0-4.9	0	0	0	0	0	0	43	0	35	31	0	0		(p .05)
	Mean	2.4	1.9	2.5	2.2	2.5	2.6	2.6	2.4	2.4	2.4	2.3	2.4	2.4	
	S.D.	.82	.67	.68	.89	.64	.62	.80	.95	.94	.85	.70	.82	.75	
C	0-.9	2	2	0	2	1	1	1	0	0	1	0	0	10	Pearson r
General	1.0-1.9	7	10	7	10	9	14	8	7	5	9	5	5	96	with age
Reason-	2.0-2.9	27	23	24	26	35	29	31	24	26	22	16	23	306	(coded 00-11)
ing	3.0-3.9	30	32	31	33	41	42	43	41	34	31	27	33	418	is r = .134
CMS	4.0-4.9	0	0	0	35	42	0	0	0	35	0	28	0	423	(p .01)
	Mean	2.3	2.4	2.5	2.5	2.5	2.5	2.6	2.7	2.6	2.5	2.8	2.7	2.5	
	S.D.	.71	.89	.68	.95	.73	.85	.73	.73	.69	.84	.81	.68	.72	
D	0-.9	5	6	5	4	2	4	5	1	1	0	1	0	34	Pearson r
Speed	1.0-1.9	18	12	17	16	14	15	13	17	7	9	6	8	152	with age
Spatial	2.0-2.9	28	29	28	29	31	36	34	33	20	23	21	22	334	(coded 00-11)
Model-	3.0-3.9	30	32	31	35	42	42	43	41	35	31	28	32	422	(P .001)
ing	4.0-4.9	0	0	0	0	0	0	0	0	0	0	0	33	423	
	Mean	1.8	2.0	1.9	2.1	2.4	2.2	2.3	2.3	2.7	2.5	2.5	2.6	2.3	
	S.D.	.84	.92	.88	.91	.86	.84	.91	.80	.83	.73	.77	.82	.83	

TABLE B - cont'd.

Factor	Score Interval	Age of child in years and months: 4-0	4-1	4-2	4-3	4-4	4-5	4-6	4-7	4-8	4-9	4-10	4-11	All	
E	0-.9	4	4	3	4	3	2	3	0	2	2	0	0	27	Pearson r
Psycho-	1-0-1.9	7	18	7	13	9	8	8	7	3	7	5	5	97	with age
motor	2-0-2.9	16=	23	17	20	20	14	20	15	8	11	9	7	180	(coded 00-11)
Control	3-0-3.9	30	32	31	35	42	42	43	41	35	31	38	33	423	is r = .271
	4-0-4.9	0	0	0	0	0	0	0	0	0	0	0	0	423	(P .001)
	Mean	2.6	2.1	2.6	2.4	2.7	2.9	2.8	3.0	3.1	2.9	3.0	3.1	2.7	
	S.D.	1.06	1.04	.99	1.08	.96	.91	.93	.78	.81	.99	.79	.74	.83	
F	0-.9	0	0	2	0	3	2	2	2	3	1	1	2	18	Pearson r
	1.0-1.9	6	18	10	17	17	16	14	16	13	12	10	11	160	with age
Origin-	2.0-2.9	22	25	29	32	34	29	35	33	29	26	26	23	343	(coded 00-11)
ality	3.0-3.9	30	32	31	35	41	42	43	41	35	31	28	23	422	P .05)
DMT	4.0-4.9	0	0	0	0	42	0	0	0	0	0	0	0	423	
	Mean	2.6	2.2	2.2	2.1	2.2	2.4	2.3	2.7	2.2	2.2	2.2	2.4	2.3	
	S.D.	.69	.83	.70	.65	.91	.92	.79	.83	.86	.77	.67	.91	.74	

[1] Means, and standard deviations, for age groups are computed from grouped data as shown; thus the standard deviations are somewhat larger than they should be. However, the mean and standard deviation for "All" are computed directly from ungrouped data, as is the value of r.

TABLE C

Mother's Education - Cumulated frequencies of scores by factors

Factor	Score Interval	Grade School	High School	College Grad.	All	
A	0-.9	0	0	1	1	Factor name (NFS)
	1-0-1.9	18	30	21	69	Ability to organize
	2-0-2.9	80	130	79	289	Spatial systems
	3-0-3.9	96	196	112	404	
	4-0-4.9	101	203	119	423	
	Mean	2.58	2.75	2.71	2.70	(see footnote at end of
	Stand. Dev.	.73	.74	.82	.71	table B) Pearson r of
	S.E. (Mean)	.07	.05	.08	.03	Mother's education with score; r =.035 (p > .05)
B	0-9	12	12	3	27	Factor Name - (DMU)
	1.0-1.9	32	47	28	107	Ability to produce a variety
	2.0-2.9	87	171	88	346	of ideas
	3.0-3.9	100	202	117	419	See Footnote 1
	4.0-4.9	101	203	119	423	
	Mean	2.21	2.37	2.52	2.40	Pearson r of Mother's
	Stand Dev.	.88	.75	.79	.75	education with score,
	S.E. (Mean)	.09	.05	.07	.04	r = .118 p > .05)
C	0-9	7	3	0	10	Factor Name - (CMS)
	1.0-1.9	47	39	10	96	General Reasoning
	2.0-2.9	87	146	73	306	
	3.0-3.9	101	200	117	418	(See footnote 1, Table B)
	4.0-4.9	101	203	119	423	Pearson r. of mother's
	Mean	2.10	2.59	2.82	2.52	education with score,
	Stand Dev.	.81	.75	.65	.72	r = .339 (P < .001)
	S.E. (Mean)	.08	.05	.06	.04	
D	0-9	16	10	8	34	Factor Name (NFU)
	1.0-1.9	52	61	39	152	Speediness in spatial
	2.0-2.9	89	153	92	334	modeling
	3.0-3.9	101	203	118	442	(See footnote 1, Table B)
	4.0-4.9	101	203	119	423	r = .162 (p < .001)
	Mean	1.95	2.40	2.34	2.26	
	Stand Dev.	.90	.83	.87	.83	
	S. E. (Mean)	.09	.06	.08	.04	

TABLE C - cont'd.

Factor	Score Interval	Grade School	High School	College Grad.	All	
E	0-.9	5	11	11	27	Factor Name Psycho-
	1.0-1.9	28	38	31	97	motor control with
	3.0-3.9	101	203	119	423	fine muscles
	4.0-4.9	101	203	119	423	(See footnote 1 (Table B)
	Mean	2.73	2.85	2.72	2.78	Pearson r of Education
	Stand Dev.	.97	.91	1.04	.83	with score,
	SE (Mean)	.10	.06	.10	.04	r= -.039 (P > .05)
F	0-.9	9	8	1	18	Factor Name (DMI)
	1.0-1.9	48	78	34	160	Originality
	2.0-2.9	88	162	93	343	(See footnote 1, Table B)
	3.0-3.9	101	202	119	422	
	4.0-4.9	101	203	119	423	
	Mean	2.06	2.28	2.42	2.28	Pearson r of Education
	Stand Dev.	.83	.82	.73	.74	with score,
	SE(Mean)	.08	.06	.07	.04	r = .141, (P ≈.005)

TABLE D

Original Correlation Matrix - Group I, Q Analysis

Child	1	2	3	4	5
1					
2	.344				
3	.159	.196			
4	.171	.094	.362		
5	-.024	.250	.366	-.229	
6	.218	.159	.141	.053	.197

Principal Components, Group I

Child	Roots	Communality	1	2	3	4
1	1.4938	.6550	.477	-.249	-.587	-.134
2	1.0752	.3771	.470	.060	-.287	.182
3	.6954	.7489	.729	-.020	.384	-.257
4	.1814	.7788	.405	-.695	.289	.213
5	.0834	.8180	.509	.722	.123	.133
6	.0009	.1523	.300	.063	-.148	.038

TABLE E

Original Correlation Matrix Group II, Q Analysis

Xhild	1	2	3	4	5
1					
2	.043				
3	.326	-.090			
4	.096	-.061	.476		
5	.126	.242	.076	.167	
6	.022	.298	.043	.215	.390

Principal Components, Group II

Child	Roots	Communality	1	2	3	4
1	1.2362	.1471	.295	-.147	-.313	-.017
2	.8621	.2608	.186	.456	-.152	.112
3	.2154	.5168	.574	-.480	-.107	.035
4	.0328	.4268	.582	-.261	.250	.014
5	-.0727	.3708	.471	.374	-.055	-.131
6	-.1474	.4042	.475	-.441	.132	.037

TABLE F

Original Correlation Matrix Group III, Q Analysis

Child	1	2	3	4	5
1					
2	.141				
3	-.186	.293			
4	-.085	.370	.674		
5	.131	.142	.283	.497	
6	-.361	-.107	-.087	-.027	.332

Principal Components, Group III

Child	Roots	Communality	1	2	3	4
1	1.7563	.2063	-.070	-.407	.398	-.016
2	.8303	.2278	.395	-.231	.103	.136
3	.3832	.5568	.729	-.068	-.266	-.002
4	.0235	.7740	.904	-.041	-.003	-.041
5	-.0683	.3064	.495	.230	.361	-.037
6	-.3666	.4872	.047	.743	.114	.042

TABLE G

Original Correlation Matrix Group IV, Q Analysis

Child	1	2	3	4	5
1					
2	.586				
3	.250	.123			
4	.605	.311	.574		
5	-.217	-.167	-.113	-.318	
6	.142	.319	.117	-.044	.490

Principal Components, Group IV

Child	Roots	Communality	1	2	3	4
1	1.9290	.5961	.774	.117	-.184	-.053
2	1.0827	.4662	.582	.279	-.347	.029
3	.4329	.2937	.472	.004	.399	.032
4	.0084	.6293	.793	-.146	.280	-.015
5	-.1906	.4910	-.362	.602	.197	-.049
6	-.2262	.5598	.101	.780	.050	.032

TABLE H

Original Correlation Matrix Group V, Q Analysis

Child	1	2	3	4	5	6
1						
2	.363					
3	-.218	-.132				
4	.198	.450	.057			
5	-.102	.005	.487	.171		
6	.617	.381	.207	.337	.431	
7	.107	.271	.108	.000	-.218	.000

Principal Components, Group V

Child	Roots	Communality	1	2	3	4
1	1.8464	.5400	.596	-.381	-.198	-.244
2	1.3344	.4073	.541	-.324	.057	.316
3	.8927	.6454	.173	.638	.443	-.070
4	.3189	.2053	.449	-.023	-.033	.321
5	.0406	.6243	.374	.690	.026	.086
6	-.1346	.8177	.897	.121	-.114	-.201
7	-.2112	.8472	.147	-.431	.800	-.063

TABLE I

Inter-Child Correlation Matrix, Group VI, 31 Selected Subjects
Q Analysis

	1	2	3	4	5	6	7	8	9	10
1										
2	.344									
3	.159	.196								
4	.171	.094	.362							
5	-.024	.260	.366	-.229						
6	.218	.159	.141	.053	.197					
7	.618	.170	-.095	.056	.163	.174				
8	.152	.601	.178	.149	.124	.302	.043			
9	.304	-.082	.264	.486	.117	.562	.326	-.090		
10	.359	-.036	.455	.433	.016	.238	.096	-.061	.476	
11	.267	.438	-.068	.064	.182	.492	.126	.242	.076	.167
12	.235	.208	.310	-.137	.305	.473	.022	.298	.043	.215
13	.112	.164	-.163	.054	.027	.070	.296	.059	.055	.091
14	.148	.552	.168	.081	.297	.307	-.109	.484	.140	.344
15	.308	.342	.339	-.251	.343	.463	.199	.445	.035	.206
16	.481	.387	.536	.000	.446	.266	.209	.514	.156	.315
17	.138	.033	.536	.263	.277	.347	-.105	-.147	.364	.511
18	-.329	-.167	.218	.331	-.005	.019	-.330	-.273	.221	-.037
19	.274	.474	.442	.228	.237	-.022	.209	.560	.009	.359
20	.386	.373	.688	.439	.224	.136	-.078	.311	.276	.563
21	.412	.269	.254	-.237	.394	.612	.348	.526	.209	-.087
22	.288	.676	.260	-.099	.397	.135	.132	.645	-.304	-.137
23	-.175	-.443	.117	.225	-.064	.150	.017	-.282	.226	.115
24	.019	-.171	.516	.271	.245	.434	.053	-.044	.415	.632
25	.540	.323	.131	-.107	-.040	.031	.281	.423	-.013	.421
26	.235	.219	.325	-.058	.526	.313	-.140	.036	.232	.408
27	-.501	.041	.004	-.054	-.018	.483	-.277	.433	.119	-.227
28	.107	.182	.090	-.144	.348	.158	.121	.201	-.098	-.124
29	-.176	.000	-.213	-.272	.294	.362	.138	.315	.171	-.435
30	.362	.636	.323	-.056	.266	.315	.195	.801	.132	.096
31	.000	-.220	.449	.375	.038	.210	-.037	-.166	.252	.610

TABLE I - cont'd.

	11	12	13	14	15	16	17	18	19	20
11										
12	.390									
13	-.081	.144								
14	.585	.356	.141							
15	.282	.639	-.186	.293						
16	.267	.611	-.085	.370	.674					
17	.131	.408	.131	.142	.283	.497				
18	-.175	.132	-.361	-.107	-.087	-.027	.332			
19	.149	.319	.162	.591	.445	.637	.138	-.027		
20	.195	.336	-.108	.534	.343	.586	.348	.051	.586	
21	.261	.599	.135	.154	.541	.520	.072	-.223	.250	.123
22	.446	.589	.102	.419	.525	.696	.097	-.185	.605	.311
23	-.257	,045	-.245	-.439	.137	-.011	.349	.479	-.217	-.167
24	.228	.388	-.178	.088	.474	.348	.557	-.016	.142	.319
25	.065	.452	.282	.243	.490	.589	.274	-.362	.540	.254
26	.412	.498	.073	.489	.328	.552	.715	-.021	.183	.308
27	.091	.036	-.102	.070	.051	-.107	.014	.350	-.107	-.228
28	.490	.413	-.023	.000	.175	.370	.171	-.335	-.024	-.146
29	.107	.308	-.120	.141	.286	.221	-.149	.244	.072	-.261
30	.299	.515	.004	.546	.604	.771	.170	-.133	.669	.365
31	-.043	.092	-.181	-.108	.134	.228	.584	.257	.076	.183

TABLE 1 - cont'd.

	21	22	23	24	25	26	27	28	29	30
21										
22	.574									
23	.113	-.318								
24	.117	-.044	.490							
25	.281	.423	-.061	.167						
26	.260	.312	-.040	.402	.363					
27	.200	.004	.318	.092	-.218	-.132				
28	.443	.545	-.050	.281	.198	.450	.057			
29	.450	.271	.218	-.075	-.102	.005	.487	.171		
30	.561	.713	-.145	.135	.617	.381	.207	.337	.431	
31	.158	-.199	.631	.693	.107	.271	.108	.000	-.218	.000

TABLE J

Principal Components, Group VI, Q Analysis

Var.	Roots	Communality	1	2	3	4	5	6	7
1	8.1374	.7343	.496	.016	.453	-.464	.248	.095	.139
2	4.3655	.5976	.565	-.384	-.203	.233	.135	.116	-.050
3	2.9645	.6010	.510	.465	-.083	.280	-.094	-.167	-.206
4	2.0423	.5291	.055	.519	-.262	.195	.372	.041	-.124
5	1.7195	.2966	.443	-.019	.192	-.009	-.219	.121	-.335
6	1.5527	.8501	.504	.179	.501	-.230	.392	.336	.128
7	.9936	.6834	.237	-.120	-.161	-.619	.384	-.218	-.163
8	.7765	.7590	.609	-.464	.114	.288	.225	-.162	.286
9	.7090	.7504	.240	.522	.107	-.211	.572	.177	-.212
10	.5926	.7994	.403	.674	-.399	-.062	.100	.107	.271
11	.5106	.5499	.485	-.128	.078	.071	.023	.523	.068
12	.3751	.6045	.702	-.006	.212	-.134	-.218	.031	.066
13	.2692	.1591	.080	-.155	-.230	-.217	.113	.122	.097
14	.0559	.8006	.611	-.137	-.158	.384	.155	.464	.111
15	-.0167	.6206	.711	-.010	.205	-.074	-.090	-.238	.098
16	-.0237	.8749	.881	.057	-.012	.018	-.161	-.267	-.171
17	-.0817	.6927	.453	.639	.070	-.019	-.251	.108	-.080
18	-.1271	.5347	-.163	.416	.337	.438	.097	-.108	-.314
19	-.1512	.7620	.669	-.076	-.320	.338	.129	-.275	.019
20	-.2018	.7618	.594	.304	-.404	.375	.107	.014	-.152
21	-.2234	.7060	.633	-.285	.333	-.306	.125	-.065	-.141
22	-.2287	.8395	.739	-.476	.017	.131	-.210	-.092	-.131
23	-.2560	.7986	-.121	.612	.488	-.112	-.009	-.402	.071
24	-.2674	.7036	.420	.671	.191	-.151	-.126	.015	.208
25	-.2918	.5962	.592	-.072	-.311	-.212	-.090	-.292	.330
26	-.3109	.7776	.616	.256	.029	-.086	-.414	.396	-.095
27	-.3142	.7128	.022	-.021	.730	.327	.263	.043	.269
28	-.3536	.5135	.397	-.185	.243	-.297	-.381	.151	-.033
29	-.3949	.6908	.201	-.305	.704	.007	.203	-.112	-.185
30	-.4551	.8618	.835	-.270	.102	.149	.124	-.212	.082
31	-.5334	.6708	.166	.773	.090	-.002	-.107	-.161	.206

TABLE K

Rotated Factor Matrix, Group VI, Q Analysis

Var		1	2	3	4	5	6
1	ABC	.304	.089	-.763	.016	.227	.061
2	ABC	.545	-.176	-.143	-.003	.016	.496
3	BCA	.404	.622	.041	.177	-.049	.114
4	BCA	-.060	.363	-.073	.562	.209	.141
5	CAB	.275	.211	.061	-.366	.044	.192
6	CAB	.166	.220	.091	-.278	.810	.201
7	ABC	-.183	-.138	-.624	-.050	.408	-.253
8	ABC	.781	-.258	.084	-.034	.137	.236
9	BCA	.057	.372	-.126	.226	.730	.059
10	BCA	.031	.709	-.378	.284	.148	.229
11	CAB	.133	.055	-.078	-.353	.277	.555
12	CAB	.483	.315	-.067	-.475	.134	.157
13	ACB	-.017	-.142	-.337	-.035	.076	.131
14	ACB	.379	.053	.008	.035	.131	.800
15	BAC	.652	.275	-.060	-.303	.147	-.023
16	BAC	.784	.417	-.183	-.214	.008	.100
17	CBA	.089	.803	.004	-.134	.081	.126
18	CBA	-.045	.278	.573	.310	.085	-.126
19	ACB	.753	.135	-.182	.266	-.089	.254
20	ACB	.445	.449	-.163	.370	-.040	.443
21	BAC	.547	-.061	-.130	-.461	.417	.004
22	BAC	.766	-.088	-.074	-.370	-.137	.294
23	CBA	-.067	.498	.317	.035	.234	-.626
24	CBA	.083	.781	-.002	-.141	.250	-.045
25	ABC	.539	.178	-.499	-.109	-.083	-.006
26	CAB	.144	.574	-.096	-.472	-.001	.445
27	CAB	.151	-.091	.709	-.047	.419	-.031
28	CAB	.185	.097	-.075	-.670	.011	.093
29	CAB	.356	-.259	.423	-.318	.426	-.168
30	BAC	.878	.025	-.047	-.140	.174	.196
31	CBA	-.016	.773	.072	.129	.093	-.202